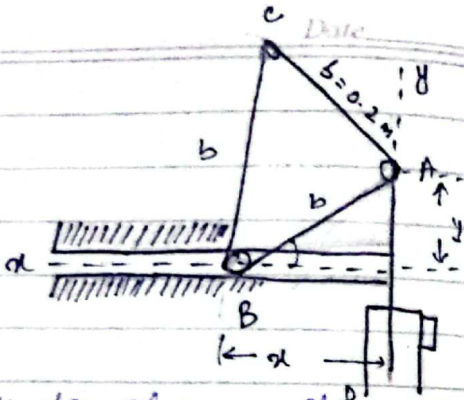
Problem



Solution.

With the x-y coordinates chosen as shown the given motion of A is $v_A = \dot{y} = 0.3$ m/s & $a_A = \ddot{y} = 0$. The accompanying motion of B is given by x and its time derivatives which may be obtained from $x^2 + y^2 = b^2$. Differentiating gives.

$$x\dot{x} + y\dot{y} = 0$$

$$\dot{x} = \frac{y}{x}\dot{y} \rightarrow (1)$$

$$x\ddot{x} + \dot{x}^2 + y\ddot{y} + \dot{y}^2 = 0 \qquad \ddot{x} = -\frac{\dot{x}^2 + \dot{y}^2}{x} - \frac{y}{x}\ddot{y}$$

with $y = b\sin\theta$, $x = b\cos\theta$ and $\ddot{y} = 0$ the equation become

$$v_B \cdot \ddot{x} = -v_A \tan\theta$$

$$a_B = \ddot{x} = \frac{v_A}{b}\sec^2\theta$$

Substituting the numerical values $v_A = 0.3$ m/s and $\theta = 30°$ given

$$v_B = -0.3\left(\frac{1}{\sqrt{3}}\right) = 0.1732 \text{ m/s}. \quad \text{Ans}$$

$$a_B = \frac{(0.3)^2(2/\sqrt{3})^3}{0.2} = -0.693 \text{ m/s}^2 \quad \text{Ans.}$$

The negative sing indicate that the velocity & acceleration of B are both to the right since x and its derivatives are positive to the left.

The angular motion of CB is the same as that of every line on the plate including AB. Differentiating $y = b\sin\theta$ gives.

$$\dot{y} = b\sin\theta$$

$$\dot{y} = b\dot{\theta}\cos\theta$$

$$\omega = \dot{\theta} = \frac{v_A}{b}\sec\theta$$

The ate angular acceleration is.

$$\alpha = \omega = \frac{v_A}{b}\dot{\theta}\sec\theta\tan\theta = \frac{v_A}{b^2}\sec\theta\tan\theta$$

Substitution of the numeric values gives

$$\omega = \frac{0.3}{0.2}\frac{2}{\sqrt{3}} = 1.732 \text{ rad/sec}$$

$$\alpha = \frac{(0.3)^2}{(0.2)}\left(\frac{2}{\sqrt{3}}\right)^2\frac{1}{\sqrt{3}} = 1.732 \text{ rad/sec}^2$$

Ans.

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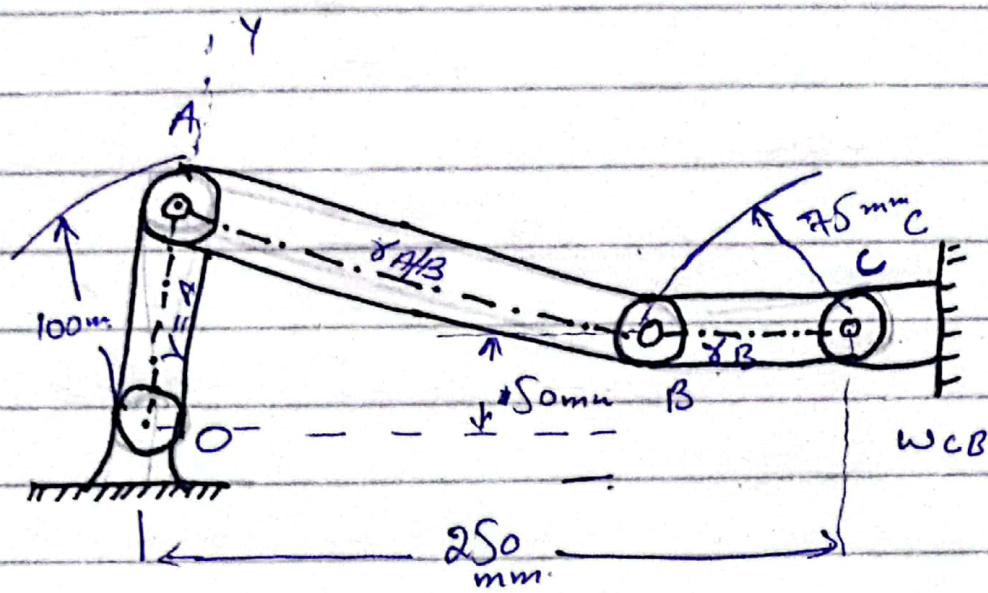
Date



Solution (Vector) The relative-velocity equation $V_A = V_B + V_{A/B}$ is rewritten as.

$$W_{OA} \times r_A = W_{CB} \times r_B + W_{AB} \times r_{A/B} \rightarrow (1)$$

where

$W_{OA} = W_{OA}k \quad W_{CB} = 2k \text{ rad/s} \quad W_{AB} = W_{AB}k$

$r_A = 100j \text{ mm} \quad r_B = 75i \text{ mm} \quad r_{AB} = -175i + 50j \text{ mm}$

Substitution gives.

$W_{OA} \times 100j = 2k \times (-75i) + W_{AB}k \times (-175i + 50j) \text{ mm}$

$100 W_{OA} j = 150i + 175 W_{AB} j + 50 W_{AB} i$

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$100 w_{OA} i = -150 J - 175 w_{AB} J - 50 w_{AB} i$

Compair the coffeient

$$100 w_{OA} i = 50 w_{AB} i \longrightarrow (A)$$

and

$$150 J = 175 w_{AB} J$$

therefore

$$w_{AB} = \frac{150}{175}$$

$$w_{AB} = 0.85 \text{ rad/sec}$$

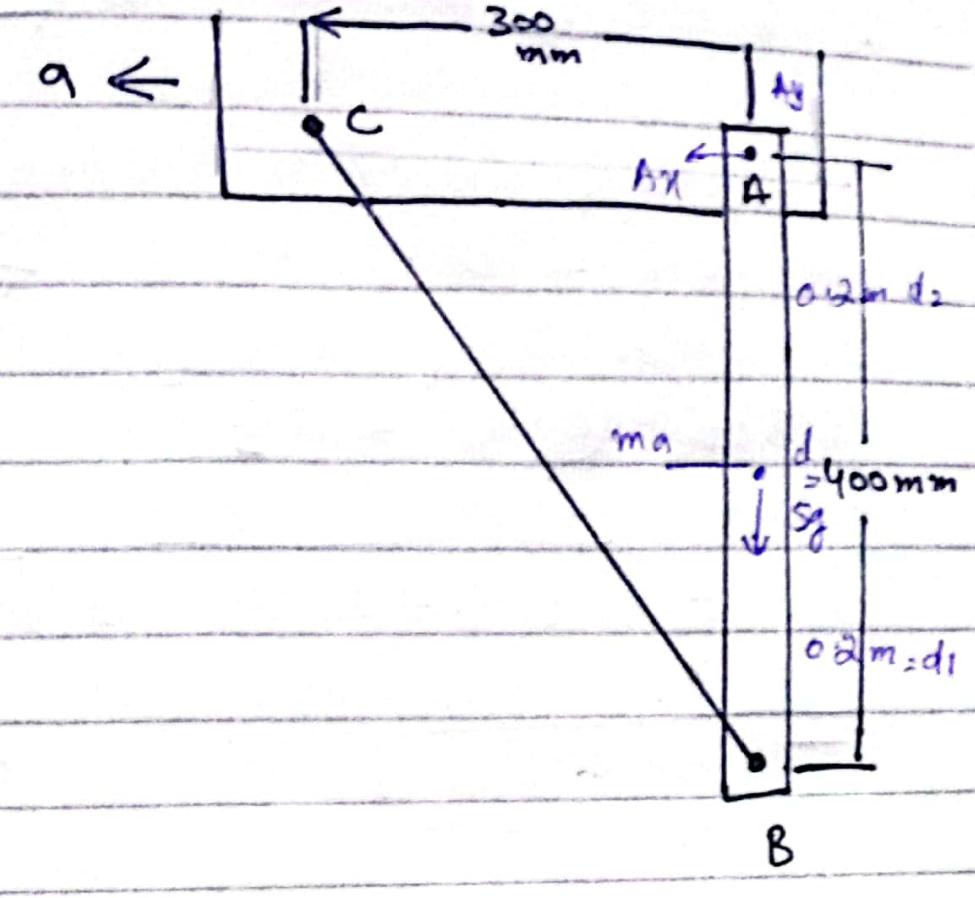
Substitute the w_{AB} value in Eq (A)

$$100 w_{OA} = 50 w_{AB}$$

$$w_{OA} = \frac{50 (0.85)}{100}$$

$$w_{OA} = 0.425 \text{ rad/sec.}$$

Problem:-



Solution:-

$$F = ma$$
$$= 5(0.6) = 3g$$

$$\Sigma M_B = ma\,d_B$$
$$0.4A_x = 3g(0.2)$$
$$A_x = \frac{3 \times 9.81 \times 0.2}{0.4} = 14.71\ N$$

$$\Sigma M_{A_x} = ma\,d_A$$
$$3/5\,T\,d = 3g(0.2) \qquad 3/5 = 0.6$$
$$T = \frac{3 \times 9.81 (0.2)}{0.4 \times (0.6)}$$
$$T = 24.5\ N$$

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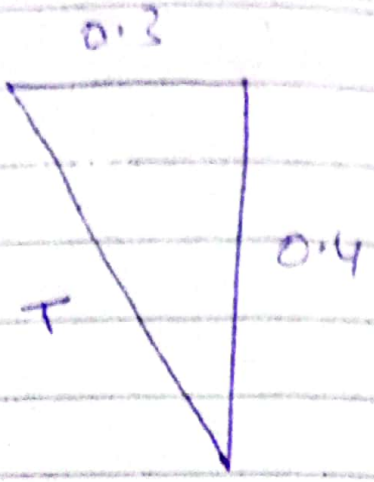
$\Sigma F_y = 0$



$(Perp)^2 + (base)^2 = (hyp)^2$

$T^2 = (0.4)^2 + (0.3)^2$

$T = \sqrt{0.16 + 0.09} = \sqrt{0.25}$

$\boxed{T = 0.5\,m}$

$\Sigma F_y = 0$

$\frac{4}{5}(24.5) + Ay - 5(9.81) = 0$

$Ay = \frac{4}{5}(24.5) - 49.05$

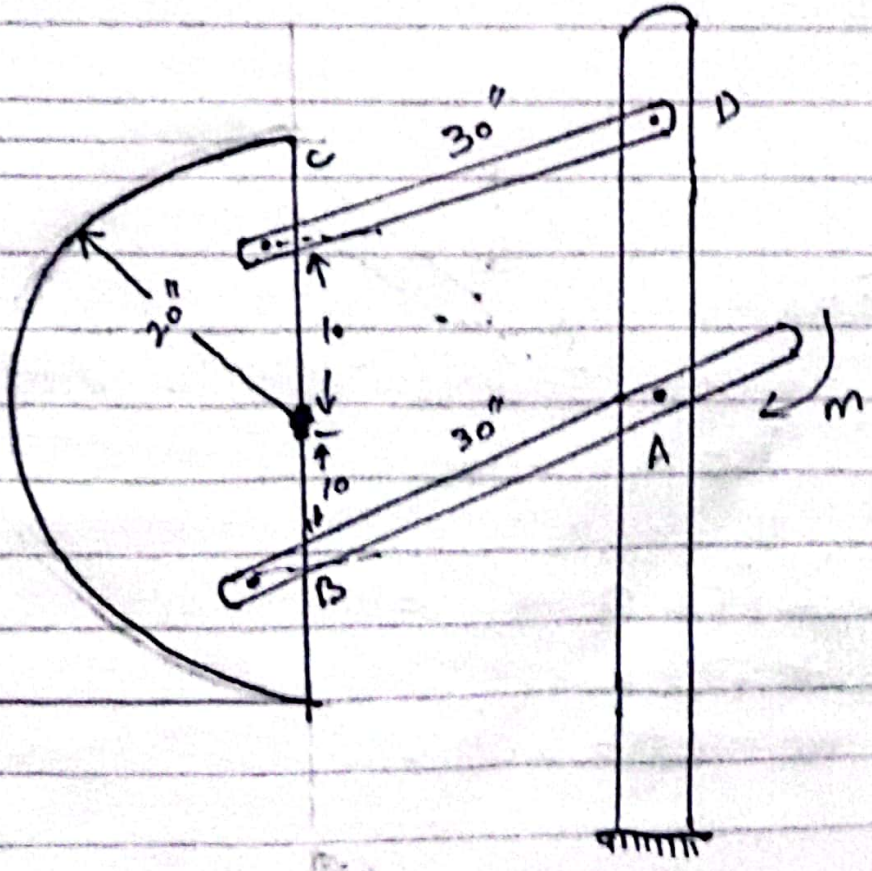
$Ay = 29.4\,N$

$A = \sqrt{(29.4)^2 + (14.72)^2}$

$\boxed{A = 32.9\,N}$

Problem:

The semicircular plate of uniform thickness weighs 150 lb and is raised from rest by the parallel linkage of negligible weight under the action of a 500 lb-ft couple M applied to the end of the link. Calculate the component normal and tangent to AB of the shear force supported by the pin at A an instant after the couple M is applied



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Solution:-

W_2 150 lb weight of the Semicircular Plate

M = 500 lb-ft applied to the end of link.

Required

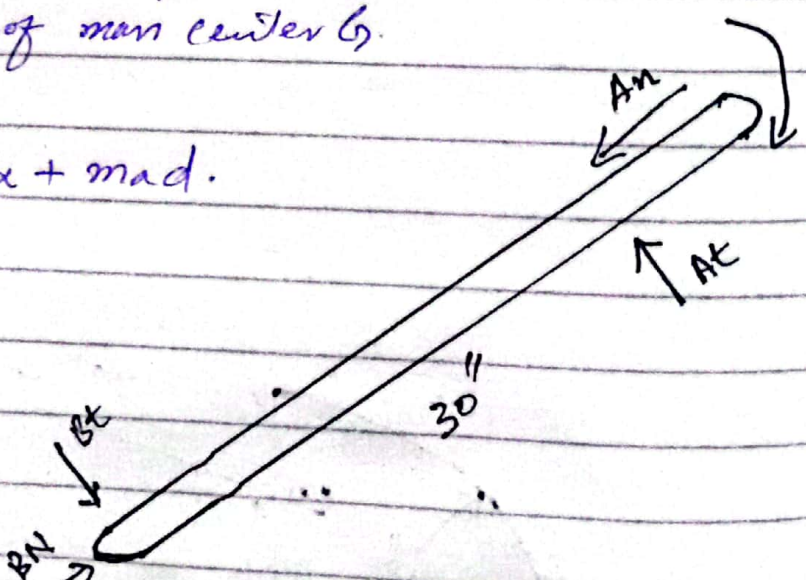
Component of AB normal & Tangent of Share force.

Using the general Eq:

$$\sum F = m\bar{a}$$

m is the mass of body. and a is acceleration of mass center G.

$$\sum M_G = \bar{I}\alpha + ma_d$$



$$\sum M_A = 0$$

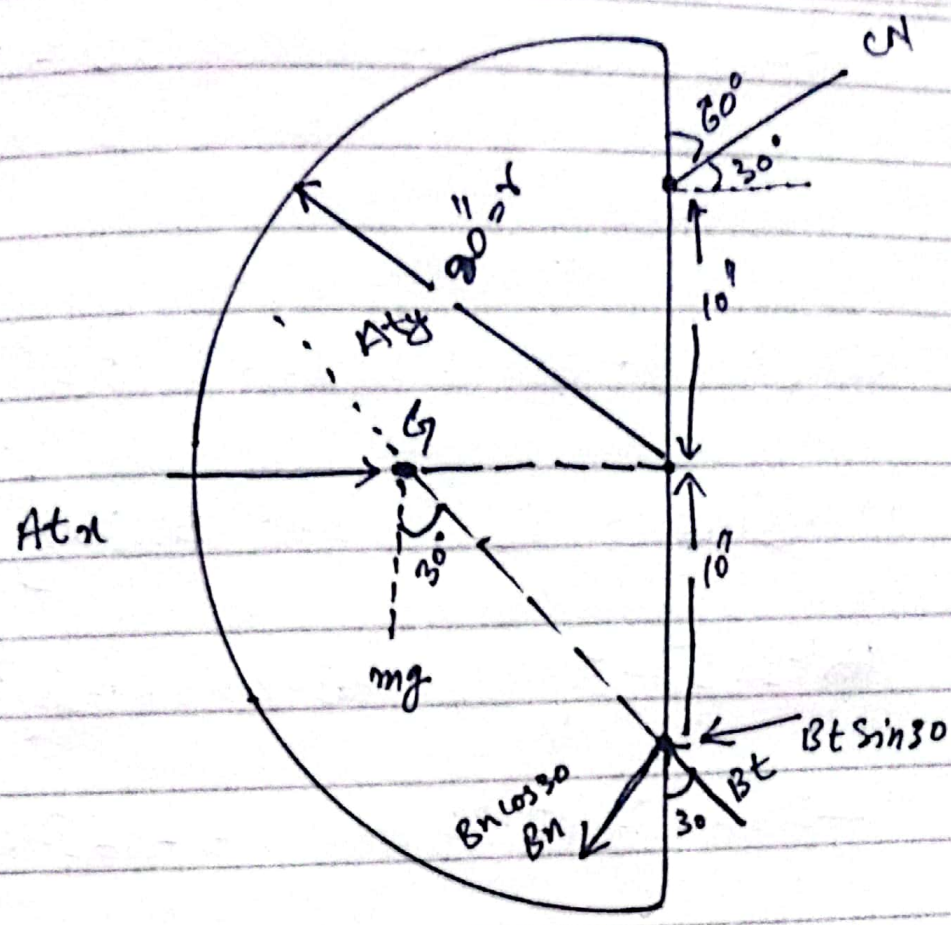
$$30\,B_t = 500(12)$$

$$B_t = 200 \text{ lb}$$

$$\sum F_t = 0$$

$$A_t - B_t = 0$$

$$A_t = B_t = 200 \text{ lb}$$



$$\sum F_t = ma_t$$

$$= 200 - 150\cos 30 = \frac{150}{32.2}\, a$$

$$a = 15.05\ ft/s^2$$

Then the Semicircular plate has a radius of 20" 20" Hence

$$\bar{r} = \frac{4r}{3\pi} = \frac{4(20)}{3(3.141)} = 8.49$$

$$\bar{r} = 08.495\ in$$

Using the moment equation about C gives.

$$\sum M_C = \bar{I}\alpha + ma_t(\bar{r})$$

$$150(8.49)\sin 30(20) - B_n\cos 30(20) = \frac{150}{32.2}\left[15.05\sin 30 \times 10 + 15.05\cos 30 \times 8.49\right]$$

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$mr - Bt\sin 30(20) + Bn\cos 30(20) = m[a_G t_d \sin 30 + a_G t_r \cos 30]$

$150(8.49) - 200(0.5)(20) + Bn(0.866)(20) = \frac{150}{32.2}[15.05 \times 10 \sin 30 + 15.5 \times 8.49^2(\cos 30)]$

$1273.5 - 2000 + 17.32 BN = 4.658[75.25 + 110.655]$

$-726.5 + 17.32\,BN = -865.949$

$17.32\,BN = -865.94 + 726.5$

$= 139.44$

$BN = \frac{139.44}{17.32}$

$\boxed{BN = 8.0516}$

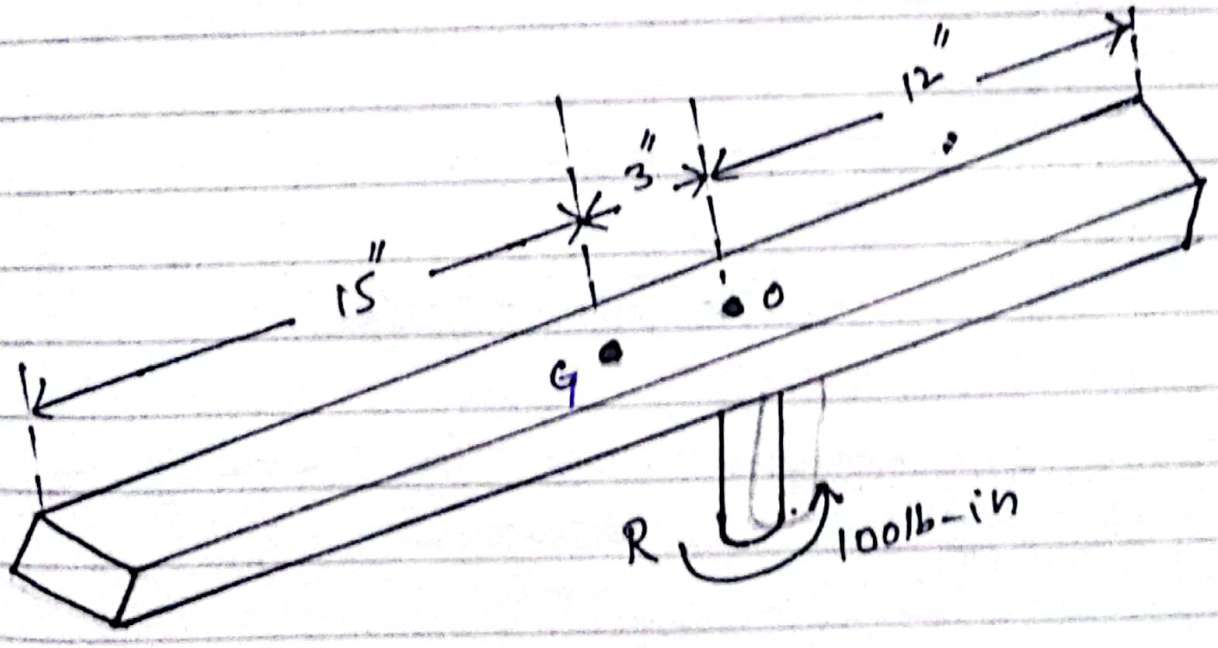
$I_m = \frac{1}{12} m l^2 =$

$I_o = I_G + md^2 = \frac{1}{12}\left(\frac{20}{32.2}\right)(30)^2 + \frac{20}{32.2}(3)^2$

$\boxed{I_o = 0.36\ slug\,ft^2}$

Problem:-

The 30-in slender bar weighs 20 lb and is mounted on a vertical shaft at "O". If a torque M = 100 lb-in is applied to the bar through its shaft calculate the horizontal force R on the bearing as the bar starts to rotate.



Solution:-

using parallel axis theorm:

$$I_o = I_G + md^2 \rightarrow (1)$$

Sub

$$I_o = \frac{1}{12} ml^2 + md^2$$

∵ 20 is weight

$$= \frac{1}{12}\left(\frac{20}{32.2}\right)\left(\frac{30}{12}\right)^2 + \left(\frac{20}{32.2}\right)\left(\frac{3}{12}\right)^2$$

$$= (0.0833)(0.6211)(6.25) + (0.621)(0.0625)$$

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$= 0.323 + 0.0388$

$= 0.362 \text{ lb-ft}^2 \text{ (slug-ft}^2\text{)}$

Apply a moment equation directly about the rotation axis O. Since rotation is given as 100 lb-in therefore

$$\Sigma M_O = I_O \alpha$$

$$\frac{100}{12} = 0.362\,\alpha$$

$$\alpha = 23 \text{ rad/sec}^2$$

For linear acceleration of the center of the gravity a_G, use the Equation

$$F_t = m a_{Gt}$$

$$a_{Gt} = d \cdot \alpha$$

$$= \left(\frac{3}{12}\right)(23)$$

$$a_{Gt} = 5.75 \text{ ft/s} \quad \text{(Steady)}$$

Summing the forces in the rod we get

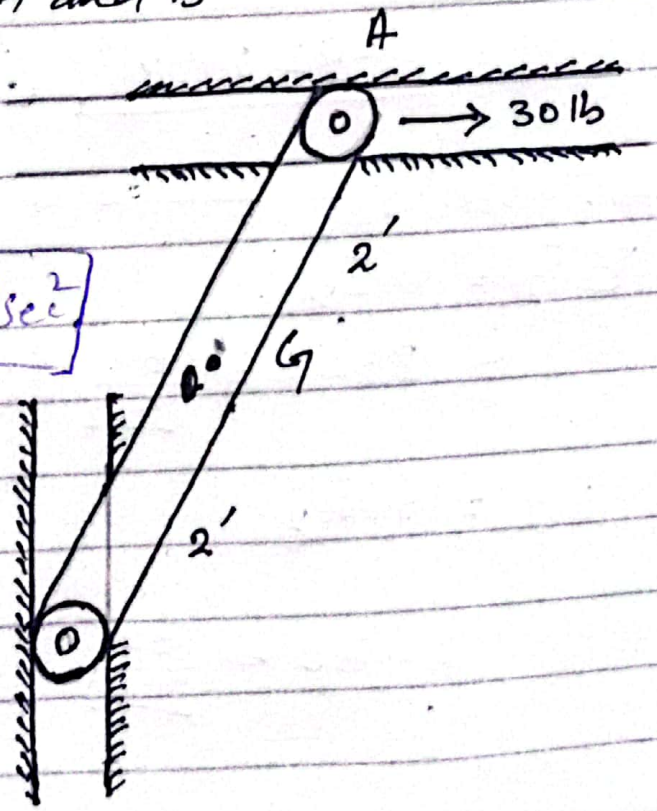
$$R - m a_{Gt} = 0$$

$$R = m a_{Gt} = \left(\frac{20}{32.2}\right)(5.75)$$

$$\boxed{R = 3.571 \text{ lb}}$$

Problem 1:

The slender bar AB weight 60 lb and moves in the vertical plane, with its ends constrained to follow the smooth horizontal & vertical guides. If the 30 lb force is applied at A with the bar initially at rest in the position for which $\theta = 30^\circ$. Calculate the resulting angular acceleration of the bar and the forces in the small end rollers at A and B



$a = 2\alpha$

$a_x = \bar{a}\cos 30^\circ$

$= 2\alpha \cos 30$

$\boxed{a_x = 1.732\alpha \text{ ft/sec}^2}$

$a_y = a \sin 30$

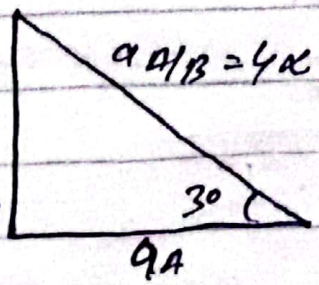
$= 2\alpha \sin 30$

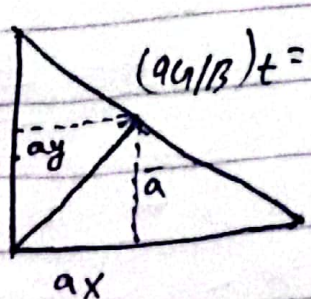
$\boxed{a_y = 1.0\alpha \text{ ft sec}^2}$

$\Sigma M_G = I_G \alpha$

$+ 30(2\cos 30) - A(2\sin 30)\, a_B$

$+ B(2\cos 30) = \frac{1}{12}\frac{60}{32.2}(4)^2\alpha$





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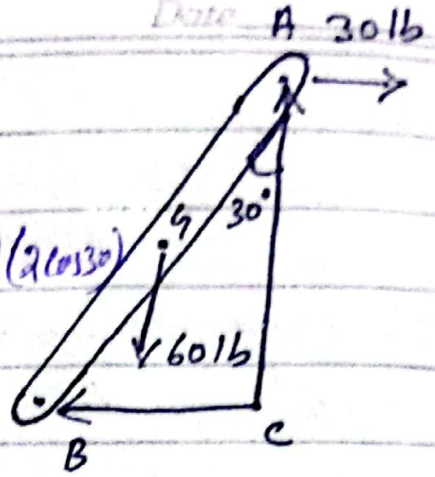


$$M_C = I_G\alpha + m\bar{a}d$$

$$= 30(4\cos 30) - 60(2\sin 30) =$$

$$= \frac{1}{12}\left(\frac{60}{32.2}\right)(4)^2\alpha + \frac{60}{32.2}(1.732\alpha)(2\cos 30)$$

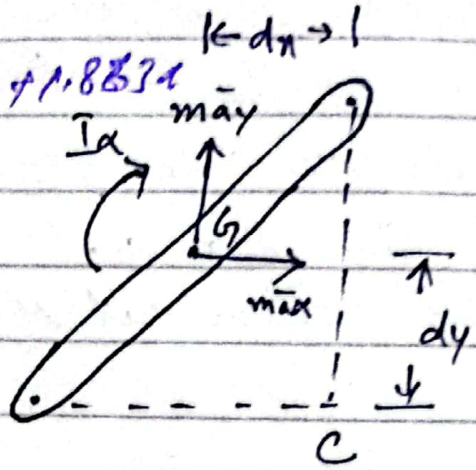
$$+ \frac{60}{32.2}(1.0\alpha)(2\sin 30)$$

$$103.92 - 60 = 2.48\alpha + 5.589\alpha + 1.863\alpha$$

$$9.932\alpha = 43.92$$

$$\alpha = \frac{43.92}{9.932} = 4.42$$

$$\boxed{\alpha = 4.42 \text{ rad/sec}^2}$$



Before upper Eq.

$$\Sigma F_x = m\bar{a}_x$$

$$= 30 - B = \frac{60}{32.2}(1.732\alpha)$$

$$F_y = m\bar{a}_y$$

$$A - 60 = \frac{60}{32.2}(1.0\alpha)$$

$$A = \frac{60}{32.2}(1.0 \times 4.42) + 60$$

$$\boxed{A = 68.21\text{b}}$$

$$30 - B = \frac{60}{32.2}(1.732 \times 4.42)$$

$$\boxed{B = 15.741\text{b}}$$